SIMPLIFYING DIETARY ASSESSMENT: THE NUTRIENT-SPECIFIC SEMI-QUANTITATIVE FOOD FREQUENCY QUESTIONNAIRE

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ABOUT GAIN

The Global Alliance for Improved Nutrition (GAIN) is a Swiss-based foundation launched at the UN in 2002 to tackle the human suffering caused by malnutrition. Working with governments, businesses and civil society, we aim to transform food systems so that they deliver more nutritious food for all people, especially the most vulnerable.

ABOUT GROUNDWORK

GroundWork is a Swiss-based organisation that provides monitoring and evaluation support to large-scale nutrition projects throughout the world by conducting quantitative and qualitative research, including large-scale micronutrient surveys and complex intervention studies. By facilitating evidence-based decision making, our goal is to support efforts to improve nutrition and health of populations living in low- and middle-income countries.

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SUMMARY

Dietary intake data are required to design, monitor, and evaluate nutrition programmes and policies; however, current dietary assessment methods are complex, time consuming, and costly. Recently, GAIN developed a semi-quantitative food frequency questionnaire (SQ-FFQ) that can be used in coverage surveys to estimate the amount of fortified and biofortified foods consumed and their contributions to nutrient intakes. However, this method is limited in that it does not account for nutrient intakes from other sources in the diet and thus cannot estimate the extent to which the nutrient gap in the diet is being filled through these programmes.

As such, we developed a nutrient-specific SQ-FFQ (NS-SQ-FFQ) module that estimates intakes of key nutrients of interest from fortified and/or biofortified foods as well as other sources in the diet using simplified dietary assessment methods. This working paper outlines the steps required to develop and implement the module and analyse the resulting data across three phases: preparation, fieldwork, and data cleaning and analyses.

We show that the NS-SQ-FFQ can yield individual-level data on intake of key nutrients, which can be used by programme planners to determine the extent to which the nutrient gap in the diet is being filled through consumption of fortified and/or biofortified foods. Further testing and refinement of the method in field settings is needed.

KEY MESSAGES

- Dietary intake data are needed to design, monitor, and evaluate nutrition programmes, yet current assessment methods are complex, time-consuming, and costly.
- We developed a nutrient-specific semi-quantitative food frequency questionnaire (NS-SQ-FFQ) module that estimates intakes of key nutrients of interest from fortified and/or biofortified foods as well as other sources in the diet using simplified dietary assessment methods.
- When appropriately designed and implemented, a NS-SQ-FFQ can yield individual-level data on intake of key nutrients, which can be used by programme planners to determine the extent to which the nutrient gap in the diet is being filled through consumption of fortified and/or biofortified foods.

BACKGROUND AND OBJECTIVE

Data on the consumption of various foods and their corresponding nutrient intakes are required to design, monitor, and evaluate nutrition programmes and policies. For nutrition programmes such as fortification and biofortification, accurate nutrient intake data is essential during the programme design stage as it provides information on the nutrient gaps in the population, which inform the amount of additional nutrients needed through the fortified and/or biofortified foods (1). Moreover, nutrient intake data are also needed during the monitoring and evaluation stages to understand the coverage of fortified and biofortified foods and consequently their potential for impact on reducing nutrient deficiencies (2).

A number of tools have been developed to estimate dietary intake data, but they differ in their assessment approach, i.e., direct or indirect, as well as their accuracy and precision (1). Food balance sheets (FBS) and household consumption and expenditure surveys (HCES) are examples of tools that can be used to indirectly assess individual dietary intake using national or household-level food availability data (3). Single or repeated 24-hour (24-h) recalls, multiple-day food frequency questionnaires (FFQ), and multiple-day food records (which sometimes require weighing foods) can be used to more directly estimate individual dietary intake (4). Direct methods tend to be more accurate and precise than indirect methods; however, the trade-off is that they are significantly more complex to implement and require greater investments in cost and time (2). As such, they are rarely used for national food and nutrition policymaking (5). Instead, many countries, particularly low- and middle-income countries (LMICs), rely on indirect measures of dietary intake to design, monitor, and evaluate nutrition programmes or, in some cases, implement programmes without any evidence assessments (5,6).

To reduce the complexity of direct dietary assessment methods at the individual-level while retaining accuracy and precision of the estimates, GAIN previously developed two simplified dietary intake methods: a simplified 24-h recall method and a seven-day semi-quantitative FFQ (SQ-FFQ) (2). Both methods were designed to provide data on nutrient intakes and their food sources at population level in LMICs. The simplification process of the methods cut across the preparation, data collection, and data analyses and reporting phases. Specifically, streamlined solutions were developed for preparatory activities, such as the listing of foods consumed, estimation of portion sizes, and collection of ingredient composition, as well as simplification of the module itself to reduce the time needed to collect information from the participant. Furthermore, the management of input data and data processing steps were simplified to minimise technical and resource requirements as well as the time needed to produce results.

A survey was conducted in Uganda to compare these simplified methods to a standard 24-h recall reference method (2,7). The simplified 24-h recall systematically underestimated the total energy intake as well as the macro- and micronutrient intakes compared to the standard 24-h recall reference method, and the intake of all assessed macro- and micronutrients was significantly lower. Comparatively, the SQ-FFQ showed a high level of conformity with the reference method; significant differences from the standard method were only found for intake of total energy, vitamin C, and vitamin A. However, when looking at the intake per 100 kcal, both methods performed acceptably, indicating that the poor performance of the

simplified 24-h recall method might have been due to underestimation of total food intake. It was concluded that the SQ-FFQ may result in similar key outcome results compared to the standard method and might be the favourable option, if costs could be further reduced.

The SQ-FFQ has been successfully used in numerous Fortification Assessment Coverage Toolkit (FACT) (8) surveys to assess individual-level consumption of fortified foods and their contributions to nutrient intakes (9–13). However, the results are limited in that they only account for nutrient intakes from the fortified foods but not other sources in the diet. Thus they cannot estimate the extent to which the nutrient gap in the diet is being filled through these programmes, a key indicator of a programme's potential for impact.

In an effort to improve the SQ-FFQ, we developed a *nutrient-specific* semi-quantitative food frequency questionnaire (NS-SQ-FFQ) that estimates the intake of key nutrients of interest from all sources, i.e., fortified and/or biofortified foods and other sources in the diet, to enable estimation of the nutrient gap in the diet and the extent to which it is being filled through these programmes using simplified dietary assessment methods. This working paper outlines the methodology for developing and implementing the NS-SQ-FFQ module and analysing the resulting data across three phases: preparation, fieldwork, and data cleaning and analyses.

METHODOLOGY

Multiple steps are required to develop and implement the NS-SQ-FFQ, which would most often be included as a module within a larger survey. The steps can be categorised across three phases: preparation, fieldwork, and data cleaning and analyses (Figure 1).

PHASE 1: PREPARATION

SPECIFY TARGET POPULATION(S) AND KEY MICRONUTRIENT(S)

As a first step, survey planners must define the population that is targeted as part of the ongoing or future programme of interest. Whilst population-based nutrition programmes, such as fortification or biofortification, are not targeted at specific population groups, researchers should nonetheless identify target populations that are at risk of malnutrition. Children 6-59 months of age and women of reproductive age (15-49 years) are frequently the target groups for large-scale fortification and biofortification programmes. For complementary feeding programmes, the target population is often children 6-23 or 6-59 months of age. Whichever target groups are selected, it is important that they are selected during this phase, since the foods consumed by different population groups can sometimes vary considerably.

After identifying the target population(s), survey planners must determine the key micronutrient(s) that will be assessed in the NS-SQ-FFQ. If the resulting data are going to be used to inform a fortification or biofortification programme, then the key micronutrients would be those that are added to the staple foods in those contexts. Micronutrients such as iron, vitamin A, zinc, folic acid, and iodine are often the main nutrients added to staple foods via large-scale food fortification and, in some cases, biofortification programmes.

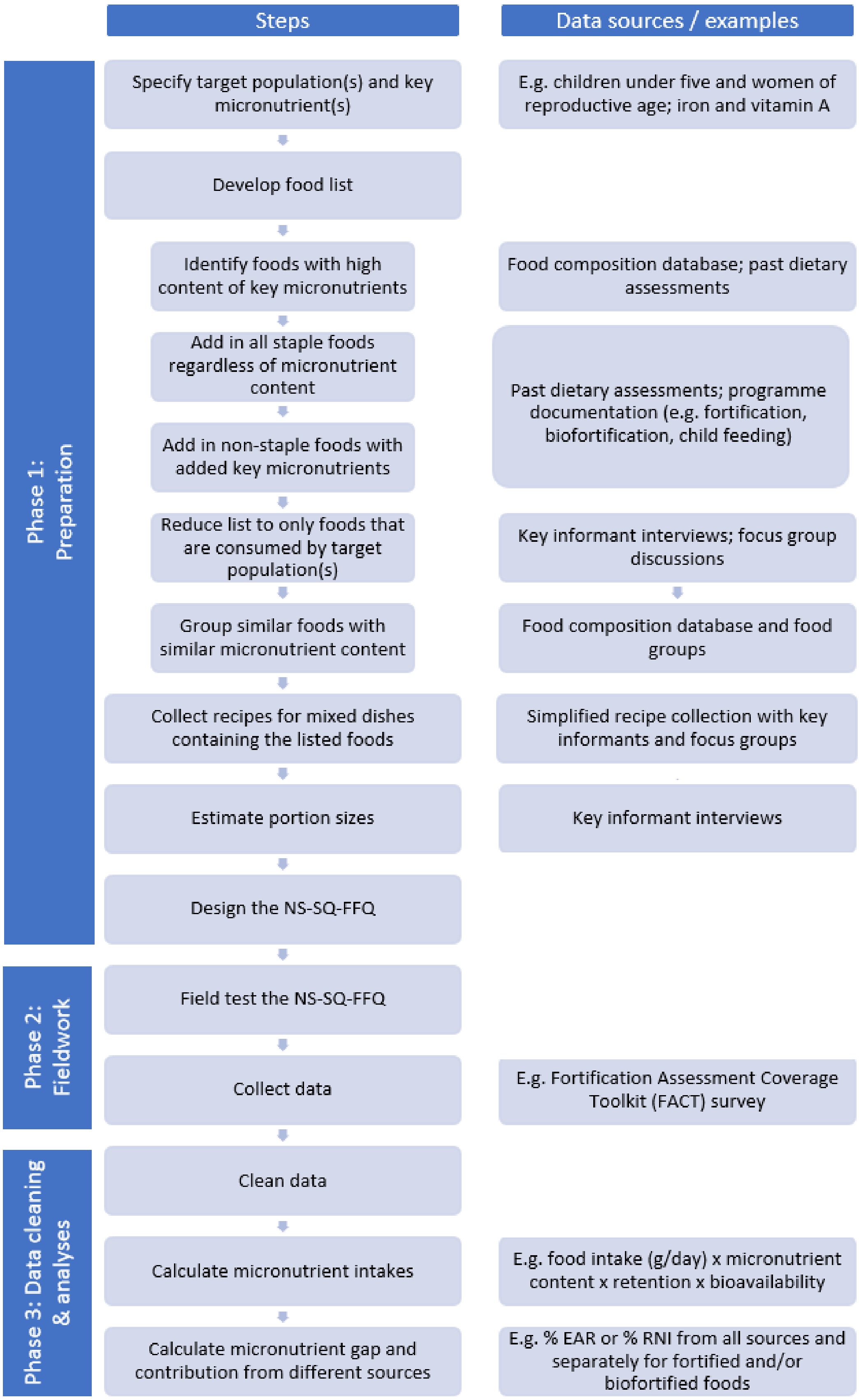

Figure 1. Steps to develop and implement the nutrient-specific semi-quantitative food frequency questionnaire (NS-SQ-FFQ) module. EAR, estimated average requirement. RNI, recommended nutrient intake.

DEVELOP FOOD LIST

As a second step, a food list containing all food items and mixed dishes that contain the key nutrients of interest and are commonly consumed by the target populations in the survey area must be developed. The development of this food list is the most labour-intensive activity undertaken during the preparatory phase. In contrast to other tools that aim to collect comprehensive dietary intake data, the food list for the NS-SQ-FFQ is typically shorter and more concise since it only captures foods that are high in the key micronutrients of interest, as opposed to all foods consumed. This is an important attribute, as the NS-SQ-FFQ will often be incorporated into a larger survey that already has other modules; therefore, it is important to keep the length of the full survey questionnaire as short as possible.

There are several sub-steps to developing the food list, as follows.

Identify foods with high content of key micronutrients

To identify foods containing high content of key micronutrient(s) (e.g. iron, vitamin A, and zinc), survey planners first need to select a food composition database containing most foods consumed in the survey area. If available, survey planners should utilise a country specific food composition database, which contains specific foods eaten by the local population. If a national food composition database is not available, public food composition tables can be accessed via the International Network of Food Data Systems (INFOODS) project of the United Nations Food and Agriculture Organization (FAO) (14). In 2012, the INFOODS project developed the West African Food Composition database (15,16), which contains a list of food items and the content of multiple nutrients per 100 grams of food and can provide a useful alternative or a good starting point. This database is provided in Microsoft Excel format, which greatly streamlines the selection of foods with high content of the key micronutrient(s). The INFOODS project contains links to many other databases from countries in other regions (e.g. ASEAN Food Composition Database) (14). As those often provide tables in PDF format, survey planners should contact the authorities that produced the desired table to request a Microsoft Excel version to increase usability of the data.[1]

Following the acquisition of a relevant food composition database, all foods (not including staple foods) with marginal levels of the key micronutrient(s) can be deleted. For example, foods containing less than 1.5 mg of iron per 100 grams and foods with less than 5 µg retinol activity equivalents (RAE) per 100 grams are not considered to make a meaningful contribution to iron and vitamin A intake, respectively.[2] Following the deletion of these foods, a list of possible foods containing the key micronutrient(s) is produced. If a national food

[1] Note: prior to the publication of this paper, an updated version of the West Africa food composition database was published (16).

[2] Whilst these nutrient thresholds are arbitrary, they offer a practical approach to help reduce the number of foods on the list whilst ensuring that foods containing meaningful amounts of key micronutrients are included. As these thresholds will not be applied to staple foods, it is unlikely that excluding foods with content below these thresholds would substantially affect estimates of nutrient intake. For example, if a 25-year-old non-pregnant woman ate 100 grams of a food containing 1.5 mg of iron and 5 µg of RAE (an extreme example), this quantity would account for only 5% and 1% of her daily recommended nutrient intake (RNI), respectively. Nonetheless, these nutrient thresholds are not prescriptive, and survey planners should consider the local context to ensure that all foods that contain meaningful amounts of key micronutrients are retained.

composition database was not used, this list will contain many foods that are not consumed by the target population(s).

Food composition databases often provide the nutrient content of foods in both their raw and processed/cooked state. If the food composition database identified for the survey contains nutrient content for cooked food, these nutrient contents can be used when applying the aforementioned thresholds for excluding foods. If the food composition table does not contain the nutrient content of a particular cooked food, survey planners must use their discretion about when to adjust the nutrient content to account for losses during preparation and cooking. If a particular food item is cooked in a consistent manner in the survey area (e.g., sweet potatoes are always boiled), then the nutrient adjustment can easily be made during the preparation stage. If, on the other hand, the food is processed or cooked in multiple ways, it may be easier to apply the processing and cooking adjustments during data analysis (as described in Phase 3: data cleaning and analyses).

Add in all staple foods regardless of micronutrient content

As a next step in developing the food list, survey planners should identify all staple foods that are eaten in the survey area and add them to the shortened list. This information can be obtained from past dietary assessments and food fortification programme information.

Common staple foods may include milled foods (e.g., wheat flour, maize flour), refined foods (e.g. vegetable oil), and unprocessed staple foods (e.g., cassava, sweet potato, millet, rice) as well as any prepared products made from these foods (e.g., bread made from wheat flour). Although many staple foods do not have a particularly high content of certain micronutrients, they are often eaten in large quantities and therefore can substantially contribute to the daily nutrient intakes. Furthermore, depending what type of survey the NS-SQ-FFQ is integrated in, information on consumption of fortified foods may be of interest to additionally measure the coverage of existing food fortification programmes and/or identify potential food vehicles for fortification.

The nutrient content of industrially fortified and biofortified foods must be identified at this stage for use during data analysis. For industrially fortified staple foods, this can be done by consulting the fortification standards in the country that stipulate the type and amount of nutrients that should be added to specific foods. However, given the poor fortification quality identified across several countries (17), these values should only be used if there is evidence (e.g., regulatory monitoring data) to suggest that the foods are being fortified to standard in the survey area. If no such evidence exists, survey planners may consider collecting samples of fortified foods and quantitatively measuring the nutrient content in the foods to get a more reliable estimate of the current nutrient content of fortified foods. For biofortified foods, survey planners must first identify the specific crop varieties available in the survey area and their corresponding nutrient contents, then calculate the average nutrient content for each biofortified crop. It is important that this step is done on a country-by-country basis, as there can be a wide range in the nutrient content of various varieties of the same food. For example, the pro-vitamin A content of orange-fleshed sweet potato (OFSP) can range from 100 to 1600 µg RAE per 100 grams (18) depending on the specific variety. Variations in nutrient content can also be high amongst different varieties within the same country. Annex

1 provides an example list of nutrient contents for conventional staple foods and their biofortified counterparts.

Add in non-staple foods with added key micronutrients

To complete the food list, survey planners should add any specialty (i.e., non-staple) foods that contain the key micronutrient(s). This is particularly relevant for complementary foods, such as fortified formulas or porridges targeted specifically at infants and young children, or cereal blends or biscuits targeted to women. These specialty products are often designed to meet a large proportion of nutritional needs and can account for a substantial proportion of the intake of multiple nutrients, even when the quantity of the food consumed is less than anticipated (19). Indeed, if there are many complementary foods available on the market, survey planners should determine which are most frequently consumed in the survey area. This can be done in consultation with the key informants that participated in the initial review of the long list of foods and in focus group discussions (FGD).

Other fortified foods distributed through nutrition and health programmes in the survey area should be included at this stage as well. These may include ready-to-use therapeutic foods (e.g., Plumpy'Nut®), micronutrient powders (e.g., Sprinkles®), and lipid-based nutrient supplements (e.g., Plumpy'Doz®, Nutributter®). However, prior to including these products in the food list, survey planners must consider if the coverage of the products warrants inclusion. The aforementioned products are frequently distributed to individuals as part of pilot programmes or in limited geographic areas. Survey planners can decide if including these food products is needed based on their knowledge of where these products are distributed and the identified survey area.

Reduce list to only foods that are consumed by target population(s)

The next step is to further reduce the already shortened list of all potential food items that contain the key micronutrient(s) to a list that contains only foods that are consumed by the target population(s) in the survey area. To do this, key informant interviews and FGD with people who are familiar with the foods consumed in the survey area can be used (see reference (2) for examples of data collection forms for food listing interviews with key informants and FGD). In situations where the survey will be conducted at the national level, the key informants and locations of FGD should be purposively selected such that the full range of geographies (e.g. rural/urban), socioeconomic groups, ethnic groups, and any other factors that may influence consumption patterns is included. The more diverse the population covered by the survey, the more interviews and/or FGD will be necessary to gather a reliable and complete list of foods. That said, three or four key informants are usually sufficient to review the food list, but additional key informants can be recruited if deemed necessary.

First, the key informants and/or FGD participants should review the food list and indicate any foods on the list that are not commonly consumed as well as any foods that are commonly consumed but do not appear on the list. It is important to include seasonable foods that will be available during the time the survey will be undertaken. Subsequently, the survey planners should eliminate any foods from the list that are not commonly consumed and add any of the additional food items that are confirmed to have high content of the key micronutrient(s) (after consulting food compositions tables or other sources). Then, a second review of the

revised list should be done to identify and eliminate any foods that are not consumed in meaningful quantities by the target population(s). An inclusion threshold of ≥15 grams per day has been used when estimating minimum dietary diversity in women (20) and thus can be used as a threshold for this step. To aid key informants and FGD participants in estimating common quantities of foods consumed, the survey planners can use photos and/or food models of various portion sizes.

Group similar foods with similar micronutrient content

The final step in developing the food list is to consolidate individual foods with similar micronutrient contents into one food group. Only similar types of foods should be grouped together so that portion size estimates of the consolidated food group are comparable.

Table 1 illustrates two scenarios where individual foods can be consolidated into a single food group. Iron, vitamin A, and zinc contents were taken from FAO's West African Food Composition database (14). The first example shows that liver from three separate sources can be combined into a single food group, with micronutrient contents from the three foods averaged. In the second example, various types of meat are consolidated into a single meat group. Of note, pork was not included in this consolidated meat group as it contains considerably less iron than the other meats listed. Whilst the micronutrient content varies for individual foods, the variations are not substantial and will be minimal when calculated as a percentage of nutrient requirements during the data analysis phase.

Table 1. Examples of consolidated food groups

Food	Code	Iron (µg/100 g)	Vitamin A (µg RAE/100 g)	Zinc (mg/100 g)
Beef liver, boiled	07_018	12.6	6020	5.3
Chicken liver, braised	07_042	12.0	9150	4.41
Lamb, liver, boiled	07_054	13.2	6020	7.06
Liver (beef, chicken, lamb), braised or boiled	**07_018, 07_042, 07_054**	**12.6**	**7063**	**5.6**
Beef, meat, 15-20 % fat, boiled	07_012	4.8	19	5.7
Beef, meat, 15-20 % fat, grilled	07_013	3.8	16	4.7
Beef, ground stewed	07_024	3.1	0	6.65
Goat, meat, boiled	07_047	3.5	0	5.15
Goat, meat, grilled (no fat)	07_048	3.3	0	5.00
Lamb/mutton, meat, moderately fat, boiled	07_049	3.1	12	4.97
Lamb/mutton, meat, moderately fat, grilled	07_050	2.9	11	4.83
Meat (Beef, Chicken, Goat, Lamb/ Mutton), boiled or stewed or grilled	**07_012, 07_013, 07_024, 07_047, 07_048, 07_049, 07_050**	**3.5**	**8.3**	**5.3**

COLLECT RECIPES FOR MIXED DISHES CONTAINING THE LISTED FOODS

Once the food list has been developed, survey planners must identify local recipes for mixed dishes that contain any of the foods on the list. A list of common recipes (and their main ingredients) can be identified through key informant interviews and FGD in the survey area. Where possible, this activity can be combined with the previous step of reducing the initial long food list to only foods that are consumed by the target population(s) to take advantage of the key informant interviews and FGD already being carried out. However, in some cases, there may need to be some lag time between the initial interviews and FGD and the finalisation of the food list before collecting recipes.

Using a simplified recipe collection method (2), the standardised recipes are developed using individual and interactive interviews with individuals who manage the daily cooking for their households and live in the survey area. As part of these interactive interviews, individuals first identify the commonly consumed recipes and the ingredients included. Subsequently, the interviewees are invited to cook the food with the survey managers. When cooking, the raw quantity of each food used is weighed prior to cooking. In situations when the food item contains non-edible materials (e.g. bones), only the weight of edible material is weighed.

It is important to note that this simplified recipe collection method was shown to be highly comparable to recipes collected using the reference method for recipe data collection (2). However, the notable exception was for the determination of consumption of meat and dark green leafy vegetables, for which the estimation of portion sizes was not accurate when measured as part of a recipe or typical dish. Thus, NS-SQ-FFQ should be designed to ask respondents about consumption and quantity of these items consumed separately from dishes in which they appear. The recipes including these foods should be used to estimate nutrient intake from other foods in the recipe *except for* meats and green leafy vegetables. To illustrate, if meat is cooked as part of a typical soup, the list should contain an entry for the soup alone (i.e., without meat) and the meat separately.

ESTIMATE PORTION SIZES

When the NS-SQ-FFQ is administered, the respondent will be required to estimate the usual amount consumed for each food item on the list. In previous studies using standard SQ-FFQs, a photo album containing the full range of possible portion sizes for each food item on the list was created to facilitate this process (2,21,22). For each photo, the corresponding weight of the edible food was recorded for use during data analysis.

For the NS-SQ-FFQ, a holistic approach to estimating portion sizes is proposed, consisting of a consolidated photo album and plastic food models made to resemble the typical quantities consumed of certain foods. Key informants can be consulted to assist with the development of these tools based on their understanding of usual portion sizes for the foods listed.

Estimating portion sizes is a complex process but can be more manageable with the NS-SQ-FFQ approach than with full dietary assessments, as the NS-SQ-FFQ approach includes a

shorter list of foods. Nonetheless, care should be taken to develop a photo album that contains multiple images showing different sizes/quantities of each food consumed by the target group(s). The only modification compared to that previously developed by GAIN (2) is to include multiple photos for certain consolidated food groups (e.g., photos representing different types and cuts of meat for the consolidated meat group described in Table 1). Moreover, for specific foods that may have portion sizes that are difficult to estimate with photos, plastic food models may be used to improve the accuracy of the portion size estimation.

Prior to developing the photo album or any food models, it is critical to identify the form of foods eaten by the target group(s). For example, if the target group for the survey is children 6-23 months of age, it is likely that many foods are served with a consistency of a purée or porridge. In such a case, it would be most appropriate to present the foods in the receptacles (e.g., bowls, cups) that are used to feed infants and young children in the survey area. This approach may be particularly useful for complementary foods that are in powder form and are prepared by simply adding water (see examples in Annex 2).

When preparing the photos to be included in the food album, the number of photos per food should be determined based on how the food is typically consumed by the target group. Previous research on portion sizes indicates that a greater number of images of food can increase the accuracy of food consumption estimates (23). It is recommended that up to eight pictures showing different quantities of a specific food be used, if appropriate to the local context (see example in Annex 3).

For foods included in consolidated groups, survey planners and key informants can use their discretion about how to display the images. For similarly shaped foods, such as liver from beef, chicken, and lamb (a consolidated group shown in Annex 4), photos of only one food item can be included in the food album. For food items that are in the same group but do not have a similar shape, multiple separate photos may be more appropriate. This could be particularly useful for a consolidated meat group, as meat from different animals will contain differing amounts of non-edible parts (e.g., bones, cartilage).

Lastly, plastic food models can also be developed. These could be specific or generic. Producing specific food models, particularly for mixed dishes, may be a time-consuming process, so discretion must be used to determine when a specific food model is most appropriate. The fieldwork logistics must also be considered, as interviewers cannot carry large numbers of food models during data collection. Nonetheless, strategic use of specific food models can be useful for commonly eaten foods or recipes with high levels of the key micronutrient(s). For example, if vitamin A were the key micronutrient, models of OFSP could be practical, as OFSP contain large quantities of pro-vitamin A and the size of OFSP tubers varies considerably. On the other hand, generic food models can be used interchangeably for foods of the same shape. For example, for each shape (e.g., round, oval, elongated, square) five different sizes would be sufficient to estimate the quantities of any food consumed. Although this approach might introduce some inaccuracy compared to the specific food models, since the shapes of different foods are not exactly the same (e.g., carrot and cucumber), the three-dimensional nature might facilitate the respondent's ability to accurately perceive and determine portion size compared to the photo album. Due to

differing densities of foods, a matrix for all the generic food models with the corresponding weights of foods with the same volumes would need to be developed prior to commencing the fieldwork.

DESIGN THE NS-SQ-FFQ

The final step in the preparation phase is to design the questionnaire. Using the example food list for iron-containing foods that was developed for Rwanda (see Annex 4), an example of a paper-based version of the NS-SQ-FFQ questionnaire is provided in Annex 5. Using this questionnaire, interviewers would make a 'first pass' with the respondent, asking whether the respondent had eaten the mentioned food item in the past seven days. For all items that the respondent ate, the interviewer would make a 'second pass' and ask a series of questions related to the frequency of consumption, additional foods consumed, and usual portion size. When asking about portion, the photo album and food models developed in the previous step are shown and the respondent selects the one that represents their usual portion in one sitting.

The questionnaire can also easily be programmed into an electronic data collection platform (e.g., Open Data Kit (ODK)). Electronic data collection platforms give programmers the ability to automate skip patterns and enforce range restrictions, and more complex programming can be used to flag potentially implausible results.

PHASE 2: FIELDWORK

FIELD TEST THE NS-SQ-FFQ

As the NS-SQ-FFQ will typically be implemented as one module within a larger survey, it should be field tested by the research team within the context of the overall survey field test. In addition to the general field testing objectives of ensuring that all sampling procedures are appropriately administered and all questions are easy to comprehend and elicit appropriate responses, the research team should specifically do a final check of the list of foods included in the NS-SQ-FFQ to ensure that no commonly consumed or high nutrient content foods are missing. This can be accomplished by conducting semi-structured open-ended interviews with respondents by asking what other foods were consumed in the past week, with the objective of identifying foods that contain sufficient amounts of the key micronutrient(s) and are consumed in meaningful quantities. Additionally, the portion size photos should also be checked to ensure that they account for the full range of intake among the target population(s). If there are any respondents that report a portion size that is smaller or larger than the range shown, additional photos should be added to account for those.

COLLECT DATA

The NS-SQ-FFQ is administered to the respondent if she/he can respond on her/his own behalf (e.g., women of reproductive age) or to a caregiver if the target population is young children (e.g., children 6-59 months). As described above in the design step of the preparation phase, the questionnaire is administered in two passes with the first asking whether the respondent (or the child) had eaten the mentioned food item in the past seven

days, and the second asking additional questions related to the frequency of consumption, additional foods consumed, and usual portion size for foods that were reported to be consumed.

If the target population for the NS-SQ-FFQ is different than the target population for the rest of the survey, then it will be important to use appropriate codes to uniquely identify the respondent and the household so that any necessary household-level data can be merged with the individual-level data during analysis.

PHASE 3: DATA CLEANING AND ANALYSES

CLEAN DATA

In the last phase, data that have been collected must be cleaned and verified prior to analysis. Ideally, errors in the data that occurred during data collection will be limited by extensive checks built into the electronic data collection system. Nonetheless, verification of the data is essential to identify any outliers—namely, individuals consuming implausible amounts of specific foods. Thus, data cleaning largely focuses on consumed quantities of foods such that the final clean dataset will consist of individuals with plausible consumption estimates.

If programming is used to flag implausible consumption of certain foods, the data will be relatively clean following the data collection step. However, if paper-based questionnaires are used, no flagging will be possible, and thus individuals consuming quantities greater than thresholds set during the preparatory phase should be dropped during the data cleaning stage. During reporting, the number of individuals excluded from data analysis should be reported alongside any data collection errors consistently made.

CALCULATE MICRONUTRIENT INTAKES

To calculate intakes of the key micronutrient(s), the steps are as follows. For each food item listed in the NS-SQ-FFQ, convert the portion size options into grams (based on a food composition table or recipe information collected as part of the preparation phase). For each food item consumed by the target individual, multiply the frequency at which the food item was consumed in the preceding week (i.e., number of times it was consumed in the previous 7 days) by the usual portion size reported in grams (as determined in previous step) and divide by 7 to get the daily grams consumed for each food item. Then estimate the daily amount of nutrient consumed from each food item by multiplying the daily grams consumed (in the previous step) by a nutrient content for each specific food item (from a food composition table or, in the case of fortified or biofortified foods, programme monitoring data or food sample analyses). Depending on the food type and preparation method used, a nutrient retention and/or bioavailability adjustment may need to be done. Finally, sum the daily amount of nutrient consumed from all food items to get the total amount of nutrient consumed daily.

Table 2 illustrates an example using fictitious data for a woman's daily consumption of various food items (already calculated as described above) and the vitamin A content of each food taken from a food composition table, adjusted for nutrient retention based on

processing/cooking method. Additional details regarding retention of vitamin A when using differing cooking approaches are given in Annex 6.

In addition to adjusting for nutrient retention factors based on cooking method, for iron specifically, bioavailability must be adjusted based on the form in which the nutrient is ingested (i.e., haem vs non-haem iron), the dietary pattern (e.g., consumption of tea or coffee during the meal) and the composition of the diet (e.g., plant-based foods high in iron-absorption inhibitors).

Table 2. Example of vitamin A intakes in non-pregnant woman of reproductive age

Foods	Preparation method	Amount consumed daily (grams/day)	Vitamin A concentration (µg RAE) per 100 grams	Nutrient Retention (24)	Intake of vitamin A (µg RAE)
Chicken wing (skin and meat)	Boiled	56	35	n/a[1]	19.6
Orange	None; eaten fresh	130	8	n/a	10.4
Carrots	Boiled	25	683	n/a[1]	170.8
Sweet potato leaves	Boiled	20	463	n/a[1]	92.6
Orange fleshed sweet potato	Boiled	250	339[2]	85%	720.4
TOTAL					**1,013.8**

[1]Retention factors already applied to µg RAE in food composition table.
[2]Kakamega variety used; beta-carotene concentration 4071 µg beta-carotene per 100 grams = 339 µg RAE per 100 grams (14).

CALCULATE MICRONUTRIENT GAP AND CONTRIBUTION FROM DIFFERENT SOURCES

To determine the micronutrient gap in the diet, there are two steps. First, define the individual's daily nutrient requirement (e.g. estimate average requirement (EAR) and/or recommended nutrient intake (RNI)) based on the individual's age, gender, and physiological status (e.g. pregnant, lactating). it is important to note that when defining the nutrient requirements for iron, it is necessary to select a bioavailability level. According the World Health Organization, a bioavailability of 5% can be used for monotonous diets consisting mainly of cereals, roots, or tubers, with negligible amounts of meat; 10% for diets primarily consisting of cereals, roots, or tubers, along with some meats and/or fruits and vegetables; and 15% for a diverse diet containing larger quantities of meats, fruits, and vegetables (25). Then, calculate the percentage of nutrient requirements (e.g. EAR) met from all food items consumed daily by dividing the total nutrient consumed daily by the EAR and multiplying by 100. Where this value is 100% or greater, the individual is meeting their nutrient requirements and there is no nutrient gap in the diet. Where this value is below 100%, the difference between 100 and the value is the nutrient gap.

These results can be further disaggregated to understand the contribution of different foods, such as fortified and/or biofortified foods, to the overall diet. This is done by summing the daily nutrient intakes from only those food items, i.e., all fortified foods or all biofortified foods, separately from the other sources in the diet. Then that value is divided by the nutrient requirement and multiplied by 100. In the example in Table 2, there is no nutrient gap in the diet as the total nutrient intake from all sources in the diet was 1013.8 μg RE, which is 203% of the RNI for vitamin A for non-pregnant women 18-49 years (i.e., 500 μg RE per day). However, when the results are further disaggregated to examine the amount of vitamin A coming from biofortified foods and other food sources separately, the substantive contribution of biofortified foods is shown. Excluding the OFSP, the other food sources contribute only 293.4 μg RE or 59% RNI for vitamin A, leaving a gap of 41%. OFSP alone contributes more than the daily requirement for vitamin A (144% RNI); when it is added to the other food sources, vitamin A intake exceeds daily requirements.

DISCUSSION

This working paper has described the stepwise approach to developing and implementing the NS-SQ-FFQ within the context of a larger survey. This type of questionnaire has numerous strengths compared to other existing methods and tools used for estimating nutrient intake, such as standard 24-h recall and full SQ-FFQ questionnaires. First, this questionnaire tool is highly streamlined and thus requires less time to administer in the field compared with other more comprehensive tools. While extensive preparatory steps (i.e., developing food lists, collecting recipes, and estimating portion sizes) are required to develop the questionnaire, these are still less intensive than those required for other dietary assessment methods with comparable accuracy. Furthermore, time spent during the preparation stage results in a more concise questionnaire with only a few food items, which likely reduces the complexity of data collection by reducing interview time and limiting the responses to a sub-set of all foods consumed. This in turn can increase the quality of data collection. Second, since the questionnaire focuses on one single or only a few key micronutrients, the food items included can be more comprehensive for a particular micronutrient than in a full FFQ questionnaire, which aims to capture the whole diet of a respondent. Third, the NS-SQ-FFQ can be a key data source for planners of fortification and biofortification programmes to answer specific questions about overall intakes of key nutrients and the current and/or potential contribution of fortified and biofortified foods. Though other methodologies (e.g., the standard 24-h recall method and full SQ-FFQ) produce large amounts of data, it can be argued that only a small proportion of that data is used by programme planners.

There are also some limitations to the NS-SQ-FFQ. First, the NS-SQ-FFQ uses retrospective data, which can lead to biased results if respondents over- or under-estimate the quantity or frequency of the foods consumed in the past week. This same limitation is faced in the implementation of the full SQ-FFQ but is reduced via the implementation of the 24-h recall method. Second, the NS-SQ-FFQ has the same issues related to generalisability as other approaches to measuring nutrient intake. Third, the NS-SQ-FFQ, like other methods, assumes that recent consumption is indicative of usual consumption. Whilst this assumption may hold

in certain cases, it does not account for changes to diet based on seasonal availability of certain foods, which may result in high consumption of certain micronutrients during specific seasons. To illustrate, the consumption of mango and papaya, two fruits with high concentrations of pro-vitamin A, is often seasonal in many areas. As such, NS-SQ-FFQ that are conducted during periods of high consumption of either fruit would overestimate the usual quantity of vitamin A provided by those fruits over a whole year. Thus, seasonality should be taken into consideration when designing the questionnaire during the preparation phase. Finally, the NS-SQ-FFQ presented here does not collect information related to nutrient consumption from other sources, such as dietary supplements and water, though additional questions on quantity and frequency of consumption of such items could be added if deemed to be substantial sources in the survey area and are not included in other modules of the larger survey.

CONCLUSION

The NS-SQ-FFQ is a simplified nutrient-specific dietary assessment tool that can be readily incorporated a larger survey. When successfully implemented, the NS-SQ-FFQ yields individual-level data on intake of key micronutrients, which can be used by programme planners to determine the extent to which the nutrient gap in the diet is being filled through consumption of fortified and/or biofortified foods.

Although the NS-SQ-FFQ is largely based on the simplified SQ-FFQ, which has been previously developed and compared to the standard 24-h recall (2), further testing and comparison to reference dietary intake assessment methods in field settings is required to determine if the NS-SQ-FFQ produces reliable and accurate estimates of nutrient intake and to quantify any time and cost savings achieved.

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ANNEX 1. MICRONUTRIENT CONCENTRATIONS FOR CONVENTIONAL AND BIOFORTIFIED CROPS

Table 3 provides baseline micronutrient concentration of beans, cassava, maize, pearl millet, rice, sweet potatoes, and wheat, obtained from Bouis and Welch 2010 (26). Bangladesh's Food Composition Table was used for the micronutrient concentration of lentils (27). The iron and vitamin A concentrations in chickpeas were obtained from the ASEAN Food Composition database(28).

Zinc and iron concentration for biofortified chickpeas was taken from Thavarajah et al. (29) and Bueckert et al. (30), respectively. Primary targeted micronutrients for the remaining biofortified crops were obtained from HarvestPlus' Biofortification Progress Briefs (31), whereas iron concentrations in rice and wheat were taken from the publications of Gregorio et al. (32) and Velu et al. (33), respectively. Bean iron concentration strongly correlates with bean zinc concentration (34), therefore we used higher zinc concentrations for iron-biofortified beans than for non-biofortified beans. For iron in sweet potato and zinc in cassava, the same concentrations as in non-biofortified varieties were assumed. For wheat, pearl millet, and maize, the micronutrient concentration of varieties recently released or with planned release are used.

Table 1. Staple crop micronutrient concentration for conventional and biofortified crops

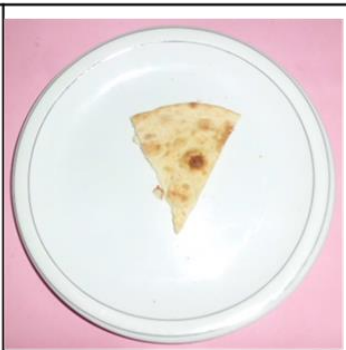
	Conventional crop			Biofortified crop		
Crop	Pro-vitamin A (µg/g)	Iron (µg/g)	Zinc (µg/g)	Pro-vitamin A (µg/g)	Iron (µg/g)	Zinc (µg/g)
Beans	0	50	32	0	94	42
Cassava	1	4	4	10	4	4
Chickpeas	1	52	53	1	112	53
Lentils	3	40	39	3	125	74
Maize	0	30	25	12	30	25
Pearl millet	0	47	47	0	71	47
Sweet potato	2	6	6	41	6	6
Rice	0	2	16	0	14	28
Wheat	0	30	25	0	47.5	33

ANNEX 2. EXAMPLE PHOTO ALBUM OF COMPLEMENTARY FOODS FOR CHILDREN

Bal Amrutham	
Teaspoon (small spoon) **&** **Tablespoon (big spoon)**	 

Tea glass	 
Cup	 
Bowl	 

ANNEX 3. EXAMPLE PHOTO ALBUM OF FOOD ITEM

Chapati / Roti			
			
1. 1/8 piece	2. ¼ piece	3. ½ piece	4. 1 piece
			
5. 1 ½ pieces	6. 2 pieces		

ANNEX 4. CONSOLIDATED FOOD LIST FOR IRON

Code	Food name in English	Iron (mg per 100 grams)
01 Cereals and their products		
01_007	Maize, yellow, whole kernel, boiled or roasted	1
01_038	Rice, white, boiled	0.5
01_042	Sorghum, whole grain, boiled	1.5
01_046	Bread, wheat, white	1.2
01_048	Bread, wheat, wholemeal	2.0
01_054	Maize, yellow, flour of whole grain	3.0
01_071	Sorghum, whole grain, white, boiled	1.6
01_072	Sorghum, flour, degermed	3.8
02 Starchy roots, tubers and their products		
02_003, 02_020	Cassava or Yam, tuber, boiled	0.8
02_004, 02_036	Cassava flour or Yam Tuber flour	1.7
03 Legumes and their products		
03_007	Cowpea, boiled	2.3
Not in lists	Beans (traditional varieties), boiled	1.8
03_023	Beans (biofortified varieties), boiled	3.6
03_034	Soya bean, boiled	2.9
04 Vegetables and their products		
04_024, 04_028, 04_029, 04_054, 04_058, 04_063	Dark leaves (amaranth, cassava, cocoyam, pumpkin, spinach, taro), boiled	2.9
04_066	Tomato paste, concentrated	3.0
05 Fruits and their products		
05_005	Breadfruit, raw	2.0
06 Nuts, seeds and their products		
06_008	Dikanut, kernel, dried, raw	3.4
Not in lists	Groundnut, shelled, dried, roasted	2.3
06_010	Groundnut, shelled, dried, raw	[3.9]
06_027	Groundnut flour, with fat	4.0

Code	Food name in English	Iron (mg per 100 grams)
07 Meat and poultry and their products		
07_018, 07_042, 07_054	Liver (beef, chicken, lamb), braised or boiled	12.6
07_012 ,07_013 ,07_019, 07_020 ,07_024 ,07_040 ,07_047 ,07_048 ,07_049 ,07_050	Meat (Beef, Chicken, Goat, Lamb/Mutton)	3
07_020	Beef, kidney, stewed	6.9
07_040	Chicken, giblets, braised	8.6
13_008	Cube, beef, dry	2.2
07_061, 07_062	Rabbit meat, stewed or grilled	1.7
07_057 ,07_058	Pork, meat, approx. 20 % fat, boiled or grilled	1.9
08 Eggs and their products		
08_002	Egg, chicken, boiled	1.7
08_003	Egg, chicken, fried	1.9
09 Fish and their products		
09_012, 09_037	Anchovy or Sardines, Canned in Oil (drained solids)	3.8
09_043	Tilapia, grilled (without salt and fat)	1.6
09_010 & 09_011 & 09_036	Anchovy or Sardine, fillet, steamed or grilled (combined)	3.0
10 Milk and their products		
10_011 & 10_12	Infant formula, powder, for 3 or 6 months of age (combined)	8.9

ANNEX 5. EXAMPLE NS-SQ-FFQ

FIRST PASS			SECOND PASS					
Food item	**Consumption**		**Frequency**		**Key ingredients**		**Portion size**	
In the last 7 days, did you consume any....{state food type from the list below}?			**If yes: In the last 7 days, on how many days did you eat the food item?**	**If yes: On those days, how many times did you eat {food item}?**	**Did this dish contain any {state the listed ingredient}? or Was this food fried in oil or fat?**		**Usually, how much of {Food item} did you eat at one sitting?**	
Food Group / Food, Beverage, or Recipe type	**No (X)**	**Yes (X)**	**If yes, number of days in last 7 days (1-7)**	**Number of times per day in last 7 days (average)**	**Ingredient**	**Circle Yes/No if ingredient was added to the food or recipe or not**	**Photo number to use**	**Choose photo size and insert Code 1-5) ***
01 Cereals and their product								
Maize, yellow, whole kernel, boiled or roasted					n/a	n/a	1	
Rice, white, boiled					n/a	n/a	2	
Sorghum, whole grain, boiled					n/a	n/a	3	
Bread, wheat, white					n/a	n/a	4	
Bread, wheat, wholemeal					n/a	n/a	5	
Maize, yellow, flour of whole-grain					n/a	n/a	6	
Sorghum, whole grain, white, boiled					n/a	n/a	7	
02 Starchy roots, tubers and their products								
Cassava or Yam, tuber, boiled (consolidated)					n/a	n/a	8	
Cassava flour or Yam Tuber flour (consolidated)					n/a	n/a	9	

FIRST PASS			SECOND PASS					
Food item	Consumption		Frequency		Key ingredients		Portion size	
In the last 7 days, did you consume any....{state food type from the list below}?			If yes: In the last 7 days, on how many days did you eat the food item?	If yes: On those days, how many times did you eat {food item}?	Did this dish contain any {state the listed ingredient}? or Was this food fried in oil or fat?		Usually, how much of {Food item} did you eat at one sitting?	
Food Group / Food, Beverage, or Recipe type	No (X)	Yes (X)	If yes, number of days in last 7 days (1-7)	Number of times per day in last 7 days (average)	Ingredient	Circle Yes/No if ingredient was added to the food or recipe or not	Photo number to use	Choose photo size and insert Code 1-5) *
03 Legumes and their products								
Cowpea, boiled*					n/a	n/a	10	
Beans (traditional varieties), boiled					n/a	n/a	11	
Beans (biofortified varieties), boiled					n/a	n/a	12	
Soya bean, boiled					n/a	n/a	13	
04 Vegetables and their products								
Dark leaves (amaranth, cassava, cocoyam, pumpkin, spinach, taro), boiled (consolidated)					n/a	n/a	14	
Tomato paste, concentrated					n/a	n/a	15	
05 Fruits and their products								
Breadfruit, raw					n/a	n/a	16	

FIRST PASS			SECOND PASS					
Food item	Consumption		Frequency		Key ingredients		Portion size	
In the last 7 days, did you consume any....{state food type from the list below}?			If yes: In the last 7 days, on how many days did you eat the food item?	If yes: On those days, how many times did you eat {food item}?	Did this dish contain any {state the listed ingredient}? or Was this food fried in oil or fat?		Usually, how much of {Food item} did you eat at one sitting?	
Food Group / Food, Beverage, or Recipe type	No (X)	Yes (X)	If yes, number of days in last 7 days (1-7)	Number of times per day in last 7 days (average)	Ingredient	Circle Yes/No if ingredient was added to the food or recipe or not	Photo number to use	Choose photo size and insert Code 1-5) *
06 Nuts, seeds and their products								
Dikanut, kernel, dried, raw					n/a	n/a	17	
Groundnut, shelled, dried, roasted					n/a	n/a	18	
Groundnut, shelled, dried, raw					n/a	n/a	19	
Groundnut flour, with fat					n/a	n/a	20	
07 Meat and poultry and their products								
Liver (beef, chicken, lamb), braised or boiled (consolidated)					n/a	n/a	21	
Meat (Beef, Chicken, Goat, Lamb/Mutton, Pork) (consolidated)					n/a	n/a	22	
Beef, kidney, stewed					n/a	n/a	23	
Chicken, giblets, braised					n/a	n/a	24	
Cube, beef, dry					n/a	n/a	25	
Rabbit meat, stewed or grilled (consolidated)					n/a	n/a	26	

FIRST PASS			SECOND PASS					
Food item	**Consumption**		**Frequency**		**Key ingredients**		**Portion size**	
In the last 7 days, did you consume any....{state food type from the list below}?			**If yes: In the last 7 days, on how many days did you eat the food item?**	**If yes: On those days, how many times did you eat {food item}?**	**Did this dish contain any {state the listed ingredient}? or Was this food fried in oil or fat?**		**Usually, how much of {Food item} did you eat at one sitting?**	
Food Group / Food, Beverage, or Recipe type	**No (X)**	**Yes (X)**	**If yes, number of days in last 7 days (1-7)**	**Number of times per day in last 7 days (average)**	**Ingredient**	**Circle Yes/No if ingredient was added to the food or recipe or not**	**Photo number to use**	**Choose photo size and insert Code 1-5) ***
08 Eggs and their products								
Egg, chicken, boiled					n/a	n/a	27	
Egg, chicken, fried					n/a	n/a	28	
09 Fish and their products								
Anchovy or Sardines, Canned in Oil (drained solids) (consolidated)					n/a	n/a	29	
Tilapia, grilled					n/a	n/a	30	
Anchovy or Sardine, fillet, steamed or grilled (consolidated)					n/a	n/a	31	
10 Milk and their products								
Infant formula, powder, for 3 or 6 months of age (consolidated)					n/a	n/a	32	

ANNEX 6. PROVITAMIN A RETENTION FOLLOWING STORAGE AND VARIOUS COOKING METHODS

The data available about the effect of various cooking (

Table 2) and drying methods (Table 3) on the pro-vitamin A concentration in OFSP are given below. Drying of OFSP is done to produce flour or chips from fresh sweet potatoes. The impacts of storage time can also impact the vitamin A concentration of OFSP (Table 4).

Table 2. Pro-vitamin A retention after different processing methods (24)

Processing method	Retention (%)
Boiling	85%
Roasting	85%
Steaming	73%
Frying	70%
Baking	69%

Table 3. Pro-vitamin A retention after different drying methods (24)

Drying method	Retention (%)
Shade drying	95%
Oven drying	85%
Sun drying	80%

Table 4. Pro-vitamin A retention of sweet potato flour and dried chips by month of storage (24,35)

Storage time	Retention (%)
1 months	70%
2 months	50%
3 months	35%
4 months	25%
5 months	15%
6 months	10%
>6 months	0%